iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** XI **Month of publication:** November 2025

DOI: https://doi.org/10.22214/ijraset.2025.75141

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue XI Nov 2025- Available at www.ijraset.com

Advanced Human Rescue Water Robot

Dr. B N Madhukar[1], Ramya P C[2], Sanjana D R[3], Ravutraya Biradar[4], Nagarjun J M[5]
Department of Electronics and Communication Engineering, AMC Engineering College Bengaluru, India

Abstract: The design and development of a simple remote-controlled (RC) robot for use in water-based human rescue operations in lakes, rivers, and seas is the main goal of this project. An RC transmitter is used to manually control the robot's movements, enabling smooth forward, backward, and directional turning. It's buoyant and waterproof body guarantees stability and floatation while in use, and its waterproof motors and effective propellers provide dependable propulsion. A rope, flotation buoy, or towing mechanism are examples of optional attachments that can be added to the robot to improve rescue functionality. These attachments can be used to either pull victims toward safety or provide immediate flotation support until trained rescuers arrive. A rechargeable battery pack powers the system, allowing for prolonged operation and rapid recharging for repeated use in an emergency. With its emphasis on simplicity, robustness, and cost-effectiveness, this design ensures that it can be quickly deployed without the need for specialized technical expertise, in contrast to complex autonomous robots that require sophisticated sensors and artificial intelligence. The suggested RC water rescue robot provides an effective way to lower the risk of drowning, speed up reaction times, and assist human rescuers in aquatic emergencies by putting an emphasis on practicality, dependability, and ease of use.
Keywords: IoT, computer vision, autonomous navigation, water safety, human rescue robot, and drowning prevention.

I. INTRODUCTION

Floods, shipwrecks, and drownings are examples of water-based emergencies that continue to be a major global concern and take thousands of lives each year. Drowning is one of the most common unintentional injury-related causes of death, according to international safety reports, especially in coastal areas and developing nations with limited access to professional rescue resources. Rescue operations must be quick and efficient in these situations, but conventional approaches frequently fall short of providing prompt responses. Environmental obstacles like strong water currents, abrupt weather changes, poor visibility, and erratic wave patterns are common for lifeguards, rescue boats, and divers. These circumstances not only make rescue efforts less effective, but they also put rescuers at significant risk, which can occasionally lead to secondary casualties. The Human Rescue Water Robot is intended to be a technological solution to these problems, providing a dependable and creative instrument that can be controlled manually or, in later versions, will include autonomous navigation. parts. The robot is stable even in rough waters because it has a buoyant, waterproof structure, high-efficiency motors, and propeller-based propulsion. Its sleek design and modern electronics let it quickly get to victims. Optional attachments like flotation rings, ropes, or towing systems let it help right away until professional rescuers get there. Rechargeable batteries power the system, which lets it run for a long time and lets it be quickly redeployed between missions. This project is different from complicated and expensive autonomous systems that need advanced sensors and a lot of technical knowledge. Instead, it focuses on making things simple, cheap, and useful, so that trained staff or volunteers can quickly set up and run the robot. The Human Rescue Water Robot could change how emergency responders work in water by making them faster, safer, and less risky for people. It could also be used on a large scale for disaster management, community safety, and lifesaving operations around the world.

II. RELATED WORK

Numerous researchers have advanced the creation of rescue robots for aquatic and perilous settings. Africa et al. [1] created the AWRO Mobile Robot, a system made just for helping with water rescues. It focuses on being able to move around and be ready to go in water right away. Amssaya et al. [2] also suggested a system for monitoring and rescuing people in African freshwater lakes that uses next-generation mobile technology, the Internet of Things (IoT), and artificial intelligence to improve real-time victim detection and communication. Simultaneously, scientists have been developing robotic solutions for high-risk and confined rescue situations. While Keerthika et al. [4] showcased an Internet of Things-based robotic system for kids stuck in borewells, Vijetha et al. [3] showcased a smart borewell child rescue system. These pieces demonstrate how sensor-based automation and robotic arms can save lives in situations where human intervention is impractical or delayed. By deploying a real-time arm-equipped child rescue robot, Jayasudha and Saravanan [7] made significant progress in this area and-belt mechanism, demonstrating a useful strategy for victim recovery.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue XI Nov 2025- Available at www.ijraset.com

In addition to water and borewell rescues, research has concentrated on enhancing rescue robots' perception and navigational skills. Deng et al. [5] developed Semantic RGB-D SLAM for rescue robot navigation, providing robust localization and mapping techniques essential for operating in dynamic and uncertain rescue environments. In their review of coal mine rescue robots with binocular vision, Zhai et al. [6] emphasized the significance of precise real-time perception in dangerous situations. Furthermore, Jiko et al. [8] demonstrated the potential of hybrid robotic platforms for a variety of rescue applications by introducing an amphibious smart rescue robot that can function both on land and in water. It is clear from these studies that although robotic rescue systems have advanced significantly, many of them are still only applicable in particular settings, like controlled lakes, mines, or borewells. Building on these contributions, the current work suggests a sophisticated human rescue water robot that combines autonomous control, IoT, and artificial intelligence for dependable and effective water-based rescue operations.

III. PROBLEM STATEMENT

Drowning is still a major global concern despite improvements in rescue operations because of environmental issues, human limitations, and delayed response times. Conventional rescue techniques mostly depend on lifeguards, boats, or manually operated equipment, all of which are frequently slow to react in an emergency and put rescuers at serious risk, particularly in choppy waters or in bad weather. Additionally, these techniques are limited in their ability to cover large aquatic areas and frequently encounter obstacles in natural water bodies, strong currents, or poor visibility. Few robotic solutions have been created especially for open water rescue operations, despite the fact that many have been investigated in confined spaces like mines and borewells. Therefore, there is an urgent need for an autonomous, intelligent, and economical solution. A water rescue robot with AI, Internet of Things connectivity, and self-navigating capabilities can cut down on delays, lower the risk to human rescuers, and greatly increase the likelihood that drowning victims will survive. In order to overcome these obstacles, this study suggests creating and deploying an Advanced Human Rescue Water Robot that can identify victims, navigate on its own in watery settings, and deliver aid in a timely manner while staying in constant contact with rescue facilities.

IV. SYSTEM DESIGN OVERVIEW

This project uses the Arduino Uno platform to design and implement a reliable master-slave wireless robotic control system. Two separate units make up the system, and they communicate with each other through a Bluetooth RFCOMM serial link. By combining sensor data and user input, the master unit serves as the main hub for control and interface. It has a GPS module for location tracking and geo-fencing, five push buttons for user commands, and an OLED display that shows the system status, sensor readings, and operating mode in real time. The slave unit receives the compiled command packets via an onboard HC-05 Bluetooth module. Actuation and execution are the focus of the slave unit. It processes command instructions via a second Arduino Uno microcontroller after receiving them from its paired HC-05 module. Five servo motors serve as the main output devices for robotic manipulation, and this controller then produces precise Pulse-Width Modulation (PWM) signals to regulate their position and movement. The independent power management system on the slave side is a crucial design factor; the servo motors are driven by a separate external 5V power source, and their signal grounds are connected to the Arduino's ground to establish a shared reference point. By separating the delicate logic circuitry from the high current requirements of the actuators, this design guarantees steady operation and guards against brownouts and possible microcontroller damage. From user input and environmental sensing to wireless communication and physical actuation, the entire system exhibits a full closed-loop workflow.

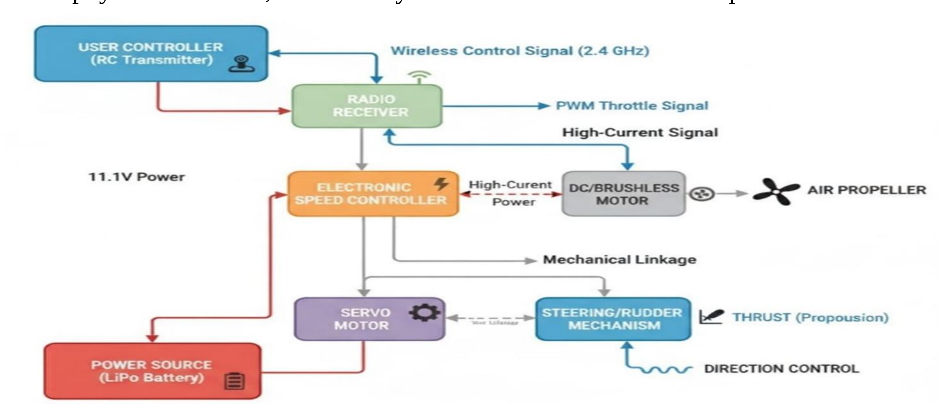

Fig 1.1. Block diagram of the proposed Advanced human rescue robot

A. Software Architecture

The Arduino IDE (C++) is used to program the Master and Slave Arduino Uno microcontrollers. The Software Serial library is used by the master unit's software to control simultaneous communication with the HC-05 Bluetooth module and the GPS module. It polls the status of five push-button-connected digital input pins continuously. It creates a distinct character command (such as "A" to "E") in response to a detected press and sends it to its paired HC-05 module via the hardware Serial port. The software of the slave unit watches for incoming data from its HC-05 module via its hardware serial port. When a valid character command is received, it uses the Servo's library to write the corresponding angle to a servo motor and maps the character to a particular PWM output pin, allowing for precise movement control.

B. Functional Workflow

The process begins with the webcam recording video, which is then pre-processed using Media pipe and OpenCV to identify and extract hand landmarks. The TensorFlow Lite model then receives pre-processed data, determines the gesture, and generates the appropriate output. The identified output can be viewed in both quiet and noisy environments because it is displayed as text and also translated into voice. The flow chart shown in Fig. 2 depicts the complete sequential process. The master unit continuously scans its five input buttons to start the operational workflow. When a user presses a button, the HC-05's master debounces the signal, determines which button was pressed, and sends a distinct predefined character command—for example, pressing Button 1 sends "A"—over Bluetooth module. This character command is received by the HC-05 module of the slave unit and transmitted to the slave Arduino via the serial connection. After decoding the character, the slave Arduino performs the appropriate action, which usually involves guiding a particular servo motor to a present location. Based on user input from the remote master unit, this one-way communication protocol guarantees low latency and dependable control of the robotic actuators.

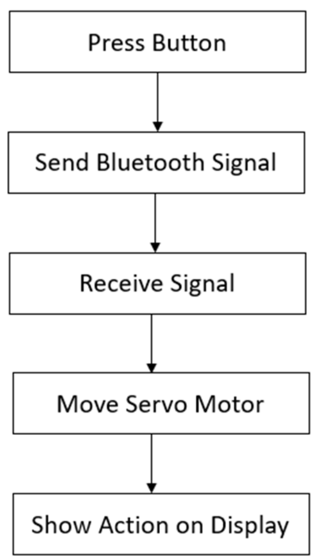

Fig 1.2: Flow chart illustrates the basic operations from user input to system response.

V. IMPLEMENTATION

A master-slave communication system serves as the foundation for the water rescue robot's implementation. Five pushbuttons that stand for various actions, including forward, backward, left, right, and open/close, are connected to the master unit, which is based on an Arduino Uno. The Arduino recognizes each button press and uses the HC-05 Bluetooth module to send a corresponding character command. The position of the robot can also be tracked by operators thanks to a GPS module that continuously provides location data that is shown in real time on an OLED screen. The Arduino Uno-controlled slave unit on the other end receives the Bluetooth signals and carries out the commands. The actions are simulated by five LEDs in the current prototype, each of which illuminates in response to a command. In order to drive the robot and carry out rescue tasks, like releasing a life jacket or rope in real-world situations, DC motors or servo motors can be easily substituted for the LEDs in this setup, which shows the system's viability.

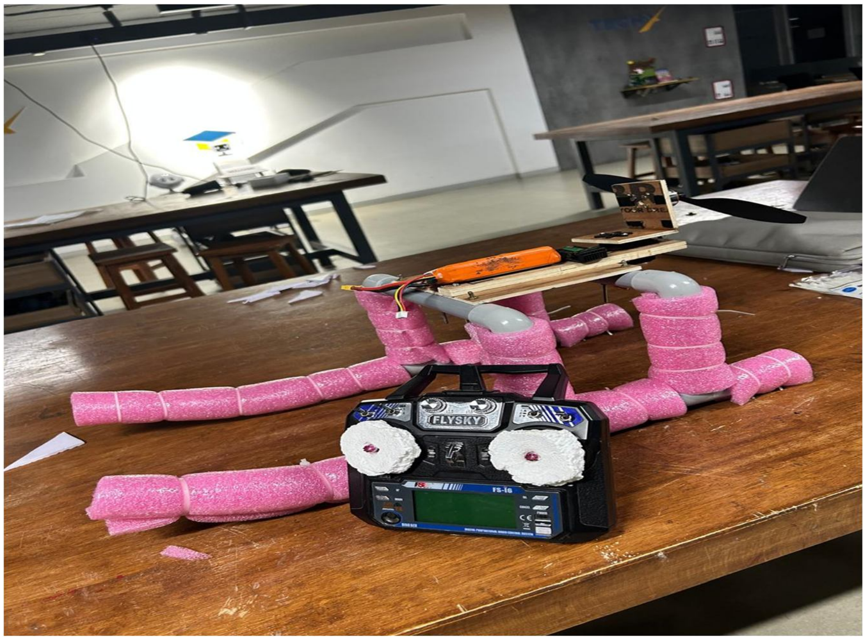

Figure 1.3: Prototype of Water Rescue Robot

This Fig shows a prototype model of a water rescue robot controlled using a Fly sky FS-i6 remote. The robot is designed with foam insulation for buoyancy and PVC pipes for structural support. It includes a motor and propeller setup for propulsion in water. This model is likely used for testing control, stability, and navigation in aquatic rescue applications.

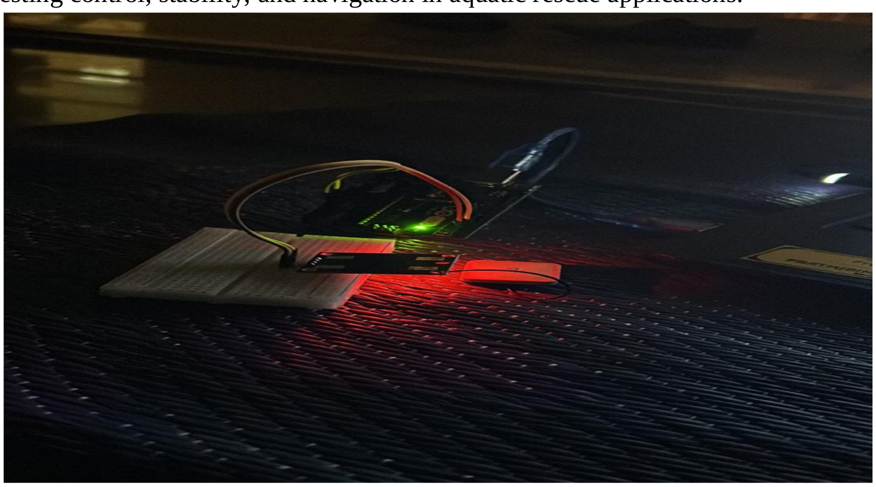

Figure 1.4: Sensor Module with Arduino Setup

This Fig shows an Arduino-based sensor setup connected on a breadboard. The red LED light indicates active power or data transmission from the sensor module. Wires are used to interface the sensor with the Arduino board for signal communication.

VI. RESULTS AND DISCUSSION

This project used Arduino Uno microcontrollers to successfully design and implement a wireless master-slave robotic control system that is fully functional. Between the slave actuator unit and the master control unit, the system created a dependable Bluetooth communication link that allowed for smooth, latency-free real-time command transmission. Five pushbuttons for user commands, a GPS module for positional data acquisition, and an OLED display that offered unambiguous visual feedback on system status and operational parameters were among the many input systems that the master unit successfully integrated. Five servo motors on the slave unit enabled the system to accurately respond to control signals by converting received digital commands into precise physical movements.

One significant accomplishment was the installation of an external power management system for the servos, which avoided microcontroller brownouts and resolved power instability problems. Under line-of-sight conditions, the system operated steadily within a functional range of roughly 10 meters, which makes it appropriate for a variety of short-range robotic applications. In addition to showcasing successful sensor integration and user interface design, the project validated the significance of appropriate power isolation in embedded systems involving motors. With possible uses in robotic arms, educational platforms, and automated guided vehicles, this work lays a strong foundation for future advancements in wireless robotics and control systems. Because of its modular design, the system can easily be expanded with more sensors or more intricate control algorithms for improved functionality.

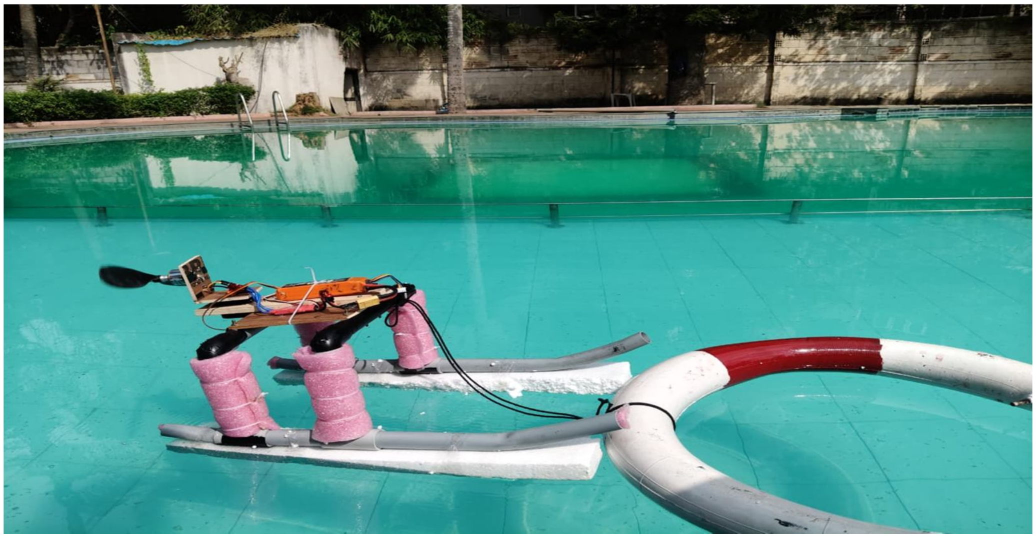

Figure 1.5: Testing of Water Rescue Robot Prototype

The water rescue robot being tested in a swimming pool environment. The robot uses foam and PVC materials to ensure buoyancy and stability on water. It is equipped with a motor and propeller for movement and a controller for operation**.** The setup demonstrates the robot's ability to perform rescue-related floating and navigation tasks.

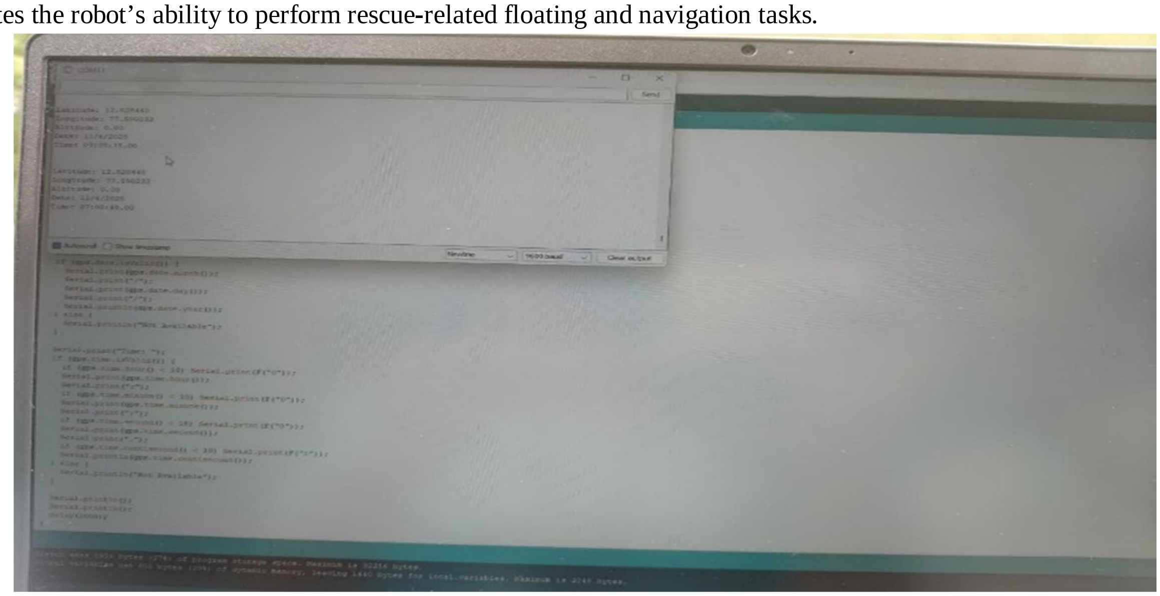

Figure 1.6: Arduino Serial Monitor Output Display

The Fig shows the Arduino IDE with Serial Monitor output. Latitude and Longitude values are received via a GPS module (12.828440, 77.590322). Date and time are displayed accurately from GPS: 1/11/2025, 07:00:18. Code is written to print GPS date, time, and location continuously using serial communication.

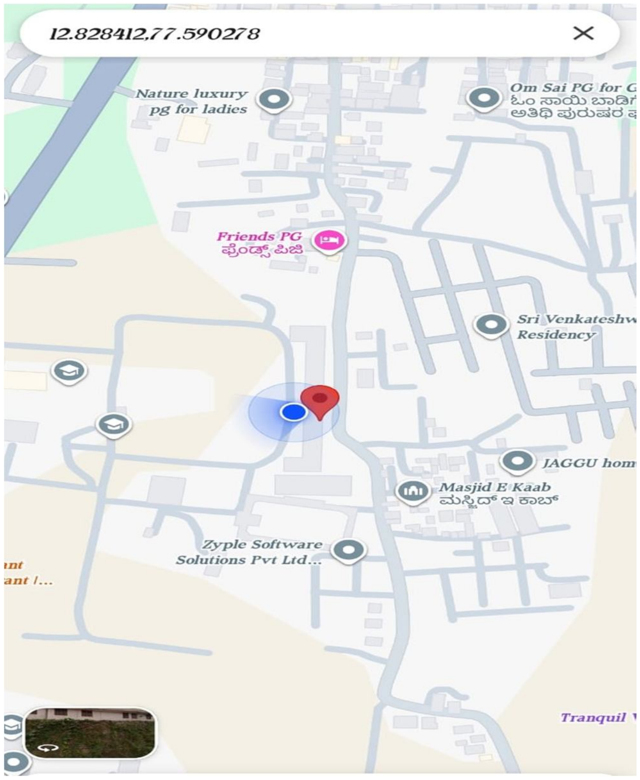

Figure 1.7: Location Map View

The map shows a location marked at coordinates 12.828412, 77.590278. The red pin indicates the destination, while the blue dot shows the current location. Nearby landmarks include Friends PG, Nature Luxury PG for Ladies, and Zyple Software Solutions Pvt Ltd. The map also displays walking/biking directions with an estimated travel time of 5 minutes.

VII. BENEFITS AND DRAWBACKS

The Human Rescue Water Robot is a useful tool for dealing with water-based emergencies because it provides a number of significant advantages. One of its main benefits is that it lowers the risks for human rescuers because the robot can be used in hazardous situations like flooded areas, strong currents, or choppy seas without a lifeguard or diver having to go into the water. Because the robot can be swiftly launched and controlled remotely, this not only guarantees the safety of trained rescuers but also enables quicker reaction times. The design's affordability and ease of use are two more significant advantages. This robot prioritizes affordability and ease of use, making it appropriate for communities, organizations, or rescue teams with limited resources, in contrast to sophisticated autonomous systems that depend on pricey sensors and intricate programming. It can function reliably in a range of aquatic conditions thanks to its sturdy body, buoyancy support, and dependable propulsion system. Its adaptability is further increased by the addition of optional attachments like flotation devices or towing mechanisms, which enable it to successfully assist with various rescue missions. Additionally, the rechargeable battery system provides rapid recharging and a longer operating duration, allowing for repeated deployment in emergency situations without significant downtime. Its ability to scale for advanced communication.

VIII. CONCLUSION

This project effectively illustrated how to use Arduino Uno’s and Bluetooth communication to design and implement a reliable wireless master-slave control system. As an intuitive control centre, the master unit successfully combined environmental data from a GPS module, visual feedback from an OLED display, and user input from buttons. With the help of servo motors and a separate external power source for the actuators, the slave unit consistently converted commands into precise physical movements. The project successfully completed its objective of establishing a smooth workflow from wireless actuation to user input, offering a strong and expandable basis for increasingly complex robotic applications.

IX. FUTURE SCOPE

There is a lot of room for future advancement and practical use of the sophisticated human rescue water robot. In the following phase, servo motors can be added to release life jackets, ropes, or other rescue gear, and DC motors can be used in place of the prototype's LEDs to allow for real movement on the water. Long-distance communication technologies like LoRa, Wi-Fi, or even 4G/5G modules can be integrated to get around Bluetooth's range restriction. Additionally, solar panels can be used to continuously charge the robot and increase its operating time. Its efficacy can be increased by AI-based victim detection that makes use of computer vision, heartbeat, or human presence in water. The design can be structurally improved to be more buoyant and completely waterproof to withstand harsh environments. Lastly, the robot can be integrated with rescue team GPS systems for better coordination in emergency situations and linked to a mobile app interface for easy control.

REFERENCES

[1] D. M. Africa, et al., "AWRO Mobile Robot: Aid for Water Rescue Operations," ARPN Journal of Engineering and Applied Sciences, vol. 18, pp. 1–6, 2023.

[2] H. Amssaya, F. Mekuria, and D. Modungwa, "A Monitoring and Rescuing System Using Next Generation Mobile, Internet of Things and Artificial Intelligence for Freshwater Lakes in Africa," in Proc. IEEE AFRICON Conf., 2023,pp.1–6, doi: 10.1109/AFRICON55910.2023.10293273.

[3] T. S. Vijetha, P. Mohan Kumar, N. Kumar, R. Sriram, and R. M. Nayak, "Smart Borewell Child Rescue System," in Proc. 14th Int. Conf. on Advances in Computing, Control, and Telecommunication Technologies (ACT), Jun. 2023, pp. 1–5.

[4] T. Keerthika, M. Dhaarini, D. A. F. Arokiadoss, J. Danica, and S. Iswarya, "Implementation of Robotics for Child Rescue from Bore Hole Using Internet of Things," in Proc. 7th Int. Conf. on Communication and Electronics Systems(ICCES),2022,pp.1–6,doi: 10.1109/ACCES54183.2022.9835918.

[5] W. Deng, et al., "Semantic RGB-D SLAM for Rescue Robot Navigation," IEEE Access, vol. 8, pp. 198372–198383, 2020, doi: 10.1109/ACCESS.2020.3034110.

[6] G. Zhai, W. Zhang, W. Hu, and Z. Ji, "Coal Mine Rescue Robots Based on Binocular Vision: A Review of the State of the Art," IEEE Access, vol. 8, pp. 56646–56659, 2020, doi: 10.1109/ACCESS.2020.2982537.

[7] M. Jayasudha and M. Saravanan, "Real-Time Implementation of Smart Child Rescue Robot from Bore Well Using Arm and Belt Mechanism," Int. J. Innov. Technol. Explor. Eng., vol. 8, no. 12, pp. 5099–5103, Oct. 2019.

[8] M. N. Jiko, M. H. Shayket, A. G. Bhuiyan, and G. Rabby, "Design and Implementation of Amphibious Smart Rescue Robot," in Proc. 2nd Int. Conf. on Electrical, Computer and Telecommunication Engineering (ICECTE), 2017, pp. 1–5, doi: 10.1109/ICECTE.2016.7879632.